



How to Teach a Protocol

When you teach your students a new protocol, we recommend that you use the following steps. This procedure, with minor modifications, can be used to teach students nearly all of the GLOBE protocols.

Good education = good data = good science. If you do a good job teaching the protocol, then your students will submit good data. If they submit good data, then you can extend the learning opportunities by having your students analyze their own data and data from other schools. This in turn helps them better understand the science domain and get even better at their measurements.

In this overview we use water temperature as the example to help you understand this process.

Phase 1 - Getting Ready

Students read the Letter from the Scientist - At the beginning of each investigation is a personal letter from the GLOBE scientists who are leading the investigations. Copy the letter and distribute it to your students. When they read this letter, your students start to make a personal connection with the scientist(s). If you cannot copy the letter, make it available to your students in some other way.

Example - Martha Conklin and Roger Bales are the scientists for the *Hydrology Investigation*. Together, they wrote the letter to the students.

Students read the Interview with the Scientist(s)

- Immediately following the letter from the scientist(s), is an interview in which the scientist(s) talk about their background, their work as scientist(s), and why they need your data. Also, the interview contains interesting anecdotes to further personalize the scientists.

Example - In their interview, Martha Conklin and Roger Bales discuss how they first became interested in science, the nature of their work as hydrologists, and what they will investigate using the GLOBE student data.

What are you measuring? - Through use of GLOBE learning activities, discussions, or field trips, you need to make sure your students understand the basic concepts included in the protocols they are performing. In reality, your students may not really understand the concept until they are fully engaged with the measurement process. However, at this stage they at least need to have an introduction to the concepts.

Example - Water temperature varies from one location to another and at different times of the year.

Phase 2 - Selecting the Study Site

Understand the guidelines for selecting the study or sample site for this measurement - Every protocol includes some carefully prepared guidelines on the selection of the study or sample site for each measurement. Review these with your students. In this *Implementation Guide* there is a comprehensive overview of the criteria for all study and sample sites to help you in this process.



Students practice measuring canopy cover for the Land Cover/Biology Investigation.



Example - The Hydrology Study Site should be a stream, river, lake, reservoir, bay, ocean, or pond within your 15 km x 15 km GLOBE Study Site.

Select the study or sample site. Based on maps of your region, the Landsat image, personal familiarity with the region and/or a field trip with your students, select the study or sample site. Review the criteria to be sure that the site matches the criteria. Convenience to your school is generally helpful in selecting study sites which should remain the same from year to year.

Example - You and your students select the Meadowbrook stream, which is in the woods a short walk from your school.

Visit the study site. If possible, take your students on a field trip to observe the study site and think about its characteristics and environment.

Example - Meadowbrook stream is a shallow stream about 5 m wide surrounded by trees and flowing down from Mountainview Hill.

Phase III - Learning and Practicing the Protocol

Introduce the instrument. Most protocols use some type of special instrument(s) to do the measurement. Show the instrument(s) to the students. Explain as well as possible how it works. Your students may not fully understand how it works until they have experience using it.

Example - A thermometer is used to measure temperature.

Demonstrate the protocol. Following the procedures detailed in the protocol, demonstrate the steps of the protocol. In most cases, you can do this demonstration in the classroom. Write the steps of the protocol on the board or on a sheet of poster paper for students to follow along.

Example - To demonstrate the water temperature protocol, use tap water in the classroom rather than water from the stream. In other respects follow the water temperature protocol as described.

Students practice the protocol. Individually or in teams, students practice the same steps that you demonstrated. Watch them closely and help them perfect their technique. Have students share

among themselves any insights they've gained on how to do the protocol correctly.

Example - Have your students work in teams in the classroom to measure tap water temperature, each team using its own thermometer.

Record and discuss the practice data. As your students practice the protocol, have them record their measurements. Review these measurements with your students and discuss the range of results. If there are any abnormal measurements, discuss why these might have occurred. This introduces the concept of data quality, which is essential for the entire GLOBE program. Help the students improve their technique to resolve any problems. Continue taking measurements until they are all sufficiently consistent.

Example - One student consistently had warmer temperature readings until his classmates noticed that he held his hands around the glass of water, which artificially warmed the water.

Phase IV - Doing the Real Thing

Get all your materials ready and go to the study site. Have your students gather the instruments, the data recording sheet, pens or pencils, and any other materials that are needed to do the measurement. Go to the study site with your class, taking the materials along.

Example - Take a bucket, rope, thermometer, pencils and data sheets on a clipboard to Meadowbrook stream.

Demonstrate the full protocol at the study site. Your students have practiced most of the protocol in the classroom, but there may be new elements for them to learn, now that they are at the actual study site. Demonstrate the full protocol and make sure your students understand it.

Example - The new element for water temperature is the use of a bucket to collect the real water sample from Meadowbrook Stream, rather than using classroom tap water.

Students do the real protocol at the study or sample site. Have your students do the protocol step by step. Watch closely to make sure that they are doing everything correctly. You may want to let them make mistakes and then correct them and learn from their mistakes as part of this process.



Example - For a fast-moving stream, students need to throw the bucket into a well-mixed area of the stream. If they do not hold onto the rope, which is tied to the bucket, the bucket will either sink or flow downstream.



Check the data for reasonableness. After your students have completed the protocol and recorded the measurement on the data work sheet, have them think about the data. Is it a reasonable value? If not, try to figure out why not and correct the problem.



Example - On route to the study site, the thermometer may have broken, causing it to show the same temperature, all the time.

Submit the data. Return to the classroom or laboratory. Use the GLOBE Web pages to submit the data to the GLOBE Student Data Server. After entering the data on screen, but before actually submitting the data entry sheet, have your students check the values to make sure that their entries are correct. If you are at a school outside the U.S. and do not have access to the World Wide Web, check with your Country Coordinator about the data entry process that you should use.



Example - The temperature of Meadowbrook Stream on this day was 16° C. The location of the Meadowbrook stream study site and the measured temperature value of 16° C were entered and sent to the GLOBE database.



Phase V - Submitting and Using the Data on an Ongoing Basis

Do the protocol on the prescribed schedule throughout the year. Many of the protocols specify daily or weekly measurements. Refer to the guidelines for details. Your students should repeat the procedure on this schedule. You can either have the whole class participate or assign the task to individuals or a team of students. They should conduct the measurements, record their observations, review the data for accuracy, and submit the data to the GLOBE database. Each GLOBE school should maintain a local record of its students observations and save this record indefinitely. This is a part of good science practice wherever measurements are made.



Example - Water temperature should be measured once every month.

Data quality requires ongoing attention. The work of the scientists requires that GLOBE student data be of consistently high quality. Emphasize this point to your students and make sure that they carefully and consistently follow the protocols and that they always review their data for reasonableness. To help them improve their accuracy, you can do some learning exercises, such as trying to create wrong measurements (which you do not submit!) and graphing their local data over time to look for spikes indicating unusual values which often indicate bad measurements. There are specific learning activities in several investigations that are built on exercises of this type.

Example - Have students warm the water in the bucket with their hands, by blowing on it, and by leaving it in the sun for an extended period of time. Have them take temperature measurements every minute to monitor this artificial warming.

Students use the data for their own investigations. The measurements that your students do are extremely valuable, not only for the scientists but also for your students to explore. They can learn important science concepts and develop skills of scientific investigation by examining their local data and data from other schools all over the world. The GLOBE software has very powerful tools to support accessing student data, analyzing it, and exploring visualizations of patterns in the data worldwide. Your students' investigations, in turn, help your students better understand the protocols and appreciate the essential role that they have in the GLOBE science and education program. There are GLOBE learning activities designed to provide a framework for getting started with investigations by exploring and comparing data sets provided by schools worldwide.

Example - Your students can compare their local water temperature measurements with measurements from other schools in the same geographical region to learn about regional water temperature variations. They share their findings with students in other GLOBE schools and with GLOBE scientists.